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PB-252 655

LARRY-CAR-FREE CHARGING OF COKE OVENS

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PREPARED FOR
INDUSTRIAL ENVIRONMENTAL RESEARCH LABORATORY

APRIL 1976

140251

PB 252 655

EPA-600/2-76-099
April 1976

Environmental Protection Technology Series

LARRY-CAR-FREE CHARGING OF COKE OVENS

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INFORMATION SERVICE
U. S. DEPARTMENT OF COMMERCE
SPRINGFIELD, VA. 22161

Industrial Environmental Research Laboratory
Office of Research and Development
U.S. Environmental Protection Agency
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TECHNICAL REPORT DATA
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1. REPORT NO. EPA-600/2-76-099	2.	3. RECIPIENT'S ACCESSION NO.
4. TITLE AND SUBTITLE Larry-Car-Free Charging of Coke Ovens		5. REPORT DATE April 1976 6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S) John Varga, Jr.		8. PERFORMING ORGANIZATION REPORT NO.
9. PERFORMING ORGANIZATION NAME AND ADDRESS Battelle-Columbus Laboratories 505 King Avenue Columbus, Ohio 43201		10. PROGRAM ELEMENT NO. 1AB015; ROAP 21AQR-042 11. CONTRACT/GRANT NO. 68-02-1323, Task 39
12. SPONSORING AGENCY NAME AND ADDRESS EPA, Office of Research and Development Industrial Environmental Research Laboratory Research Triangle Park, NC 27711		13. TYPE OF REPORT AND PERIOD COVERED Task Final; 10/75-2/76 14. SPONSORING AGENCY CODE EPA-ORD

15. SUPPLEMENTARY NOTES Task officer for this report is R. C. McCrillis, Mail Drop 62, Ext 2557.

16. ABSTRACT The report discusses advantages of preheating coal before charging it into coke ovens, as an introduction to the use of charging systems that do not use larry cars. Two larry-car-free systems are discussed. A third system, which uses a larry car for charging preheated coal, is also discussed to provide more complete coverage of the charging of preheated coal. The two larry-car-free charging systems offer good possibilities for eliminating emissions generated during the usual method of charging coke ovens with larry cars. (The report responds to Item AM-2-2 of the Protocol of the First Working Meeting of the USA/USSR Task Force on Abatement of Air Pollution from the Iron and Steel Industry.)

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Air Pollution	Air Pollution Control	13B
Iron and Steel Industry	Stationary Sources	11F
Coking	Coke Oven Charging	13H
Coal	Larry Cars	21D
Heating	Coal Preheating	13A

18. DISTRIBUTION STATEMENT Unlimited	19. SECURITY CLASS *(This Report)* Unclassified	21. NO. OF PAGES 42
	20. SECURITY CLASS *(This page)* Unclassified	22. PRICE $4.00/2.25

EPA Form 2220-1 (9-73)

PRICES SUBJECT TO CHANGE

EPA-600/2-76-099
April 1976

LARRY-CAR-FREE CHARGING OF COKE OVENS

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Contract No. 68-02-1323, Task 39
ROAP No. 21AQR-042
Program Element No. 1AB015

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Prepared for

U.S. ENVIRONMENTAL PROTECTION AGENCY
Office of Research and Development
Washington, DC 20460

SUMMARY

The advantages of preheating coal before charging it into coke ovens are discussed as an introduction to the use of charging systems that do not use larry cars. Two larry-car-free systems are discussed. A third system which does use a larry car for charging preheated coal is included to provide a more complete coverage of the charging of preheated coal. The two larry-car-free-charging systems offer good possibilities for eliminating emissions generated during the usual method of charging coke ovens with larry cars.

"This report was prepared in response to Item AM-2-2 of the Protocol of the First Working Meeting of the USA/USSR Task Force on Abatement of Air Pollution from the Iron and Steel Industry."

РЕФЕРАТ

Обсуждаются преимущества предварительного нагрева шихты перед загрузкой её в коксовую печь, с целью ознакомления с методом применения загрузочных систем без загрузочных вагонов. Рассматриваются две системы, не применяющие загрузочных вагонов. Также рассматривается 3-я система, применяющая загрузочный вагон для завалки подогретого угля, чтобы дать полное представление о процессе загрузки подогретого угля. Две рассматриваемых системы без загрузочных вагонов перспективны в отношении предотвращения вредных выбросов в атмосферу, имеющих место при обычном методе загрузки коксовых печей при помощи загрузочных вагонов.

Этот отчет представлен в согласии с пунктом АМ-2-2 протокола первого рабочего совещания Группы США/СССР по борьбе с загрязнением атмосферы металлургической промышленностью.

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I. INTRODUCTION

Coke is the principal fuel used in the manufacture of steelmaking pig iron. As a result, it accounts for the greatest amount of fuel used in the production of steel products. During the manufacture of coke, emissions are released to the atmosphere. Control of coke-plant emissions has been a continuing problem to coke-plant operators. Emissions are generated during charging of coal to the coke ovens, during the coking cycle, when pushing incandescent coke from the ovens, and during quenching of the coke. This report is concerned with the control of emissions during the charging of coal to the ovens.

Emissions from coke ovens during the charging of moist coal from larry cars may constitute as much as 70 percent of the total emissions from the operation of a coke plant. The emissions associated with the charging operation include (1) particulates and gases emitted with the steam formed when the moist coal contacts the incandescent walls of the ovens, (2) particulates and gases emitted from the ovens before the charging-hole lids can be replaced and sealed on the charging holes, (3) coal dust spilled during the charging operation, and (4) particulates, smoke, and gases emitted during the coal-leveling operation.

This Protocol Report discusses the use of a new technology that eliminates the use of larry cars for charging coal to coke ovens. Two new processes reportedly eliminate or minimize emissions during the charging operations.

II. THE UNITED STATES COKE INDUSTRY

Coke produced in by-product coke ovens is consumed by the integrated iron and steel industry, the gray iron foundry industry, and to a lesser extent by a few other industries. By-product plants associated with the integrated iron and steel industry produce blast-furnace coke and are generally located at the steel-plant sites. Coke plants producing coke for sale to the gray iron foundry industry, steel industry, and other industries are called "merchant coke producers" and their product is called "merchant coke". Most coke plants are located in the northeastern United States (north of the Ohio River and east of the Mississippi River) and in Alabama. The distribution of by-product coke plants throughout the United States is shown in Figure 1.

Table 1 lists the number of companies and plants making blast-furnace and merchant coke. Production of blast-furnace pig iron, the coke consumed to make the pig iron, and the coke rate are shown in Figure 2 for the years 1960 through 1974.[1] The decrease in coke rate (tonne coke/tonne pig iron or net ton coke/net ton pig iron), resulting from the application of improved blast-furnace smelting technology, permitted the production of an increasing amount of blast-furnace pig iron in the period 1960-1974 with little increase in coke-plant capacity.

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Figure 1. Distribution of coke plants in the United States

TABLE 1. BY-PRODUCT COKE PLANTS

Type of Coke Produced	Companies	Plants	Batteries	Coke Ovens
Blast-furnace coke	20	44	169	10,733
Merchant coke	13	18	38	2,015
Total	33	62	207	12,748

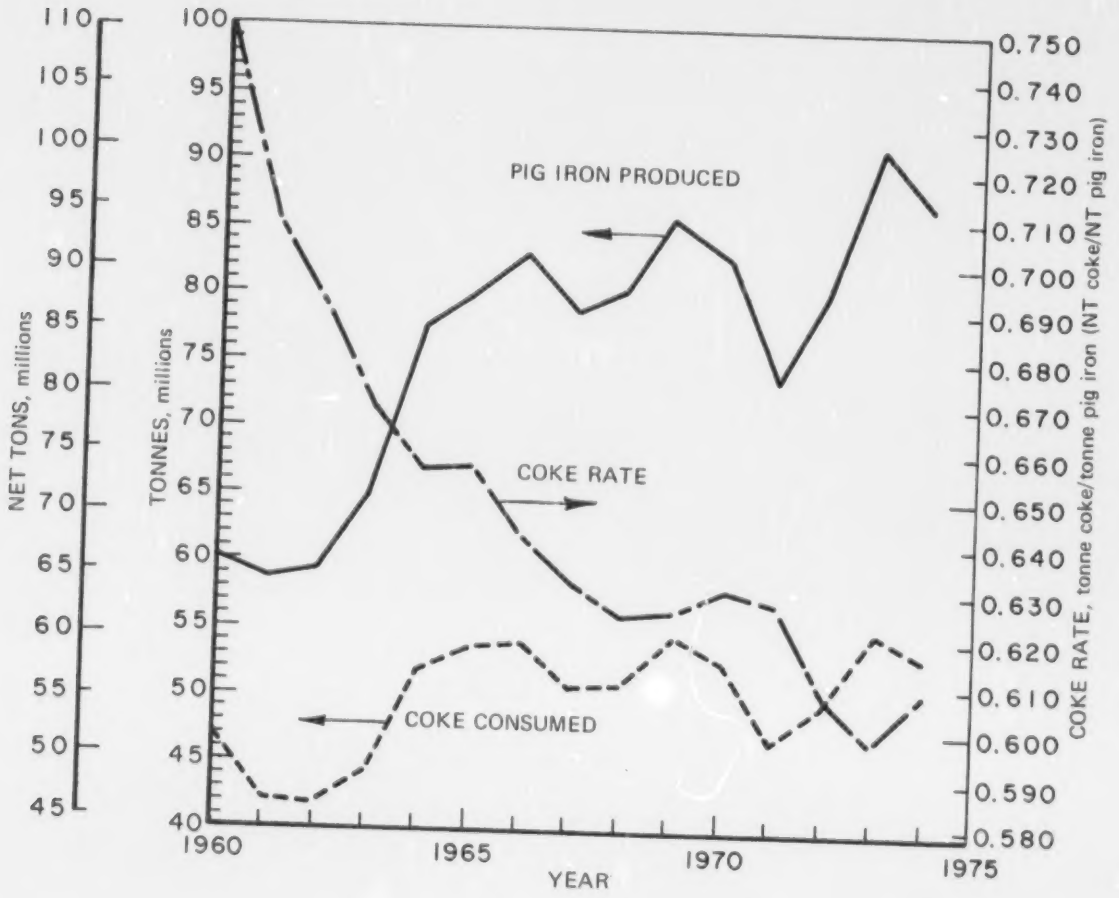

Figure 2. Blast-furnace pig iron produced, coke consumed, and coke rate in the U. S. integrated iron and steel industry

III. COKE-OVEN CHARGING EMISSIONS

Emissions generated during the charging of coke ovens are caused by the following factors[2]:

(1) Coal entering an oven rapidly occupies about 90 percent of the space in the oven, displacing the air (or other atmosphere) present in the empty oven. Much of the displaced air may rush out through open charging ports, carrying with it particulate and other matter.

(2) Conventional blends of coals for coking contain about 8 percent moisture. Some of the moisture in the newly charged coal immediately comes into contact with the incandescent walls and floor of the oven, and is flash vaporized. For each 0.1 percent of moisture vaporized from the coal, the volume of steam produced at 260 C (500 F) is about 1.7 times the volume of the coal. This steam exiting through the charging ports carries particulate matter into the atmosphere.

(3) The coal itself is susceptible to thermochemical breakdown as soon as it has become heated to over 260 C (500 F). Smoke, tar vapors, and gases formed by these pyrolysis reactions can be emitted to the atmosphere.

Characterization of emissions generated during the charging of coal to coke ovens is difficult, primarily because of the problems associated with collecting samples during the charging operation. Reports have been published pertaining to the characterization of emissions found on the top of coke batteries, along the coke-battery benches, and on the ground near coke batteries.[3-7] Only one published report has been located pertaining to the sampling and analysis of

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emissions during charging of a coke oven.[8] It was a result of work sponsored by the U. S. Environmental Protection Agency and conducted at an operating steel-plant coke battery. It supplemented research work sponsored jointly by the U. S. Environmental Protection Agency and the American Iron and Steel Institute on the development of a new larry car and an improved coal-charging procedure for coke batteries having only one gas-collecting main.[9] The new device is often called the AISI/EPA larry car. The coke battery used in the research had 79 ovens, each capable of coking 15.0 tonnes (16.5 net tons) of coal.

Gaseous and particulate emissions were collected during the research work on the AISI/EPA larry car. The emissions were collected by means of a special shroud around each drop-sleeve and charging hole. The major gaseous emissions measured were: total hydrocarbons, carbon monoxide, carbon dioxide, nitrogen oxides, sulfur dioxide, hydrogen sulfide, methane, ammonia, phenol, and cyanide. The size distribution of the particulates was determined and they were analyzed for tar content. The reported average volumes of some of the gases emitted during charging are listed in Table 2.[9] Analyses of the

TABLE 2. VOLUMES OF GASES EMITTED DURING CHARGING OF 15.0 TONNES (16.5 NET TONS) OF COAL

Constituent	Standard Larry Car		AISI/EPA Larry Car	
	std cu m	std cu ft	std cu m	std cu ft
Total hydrocarbons	0.96	33.8	0.83	29.1
Carbon monoxide	0.50	17.5	0.26	9.0
Carbon dioxide	0.83	29.4	0.13	4.7
Nitrous oxide	0.002	0.08	0.0002	0.006
Other nitrogen oxides	0.003	0.11	0.001	0.05

gaseous constituents measured are given in Table 3.[9] The size distribution of particulates collected during the various tests is shown in Figure 3.[9] It was not possible to determine the unit weight of emissions, i.e., grains per tonne (pounds per net ton) generated during

TABLE 3. MEASURED CONSTITUENT CONCENTRATIONS IN GASES EMITTED DURING THE CHARGING OF 15.0 TONNES (16.5 NET TONS) COAL

Constituent	Unit	Standard Larry Car			AISI/EPA Larry Car		
		Maximum	Minimum	Average	Maximum	Minimum	Average
Ammonia	ppm	130.6	BDL*	**	BDL*	BDL*	**
Carbon dioxide	percent	8.1	0.0	0.5	1.5	0.0	0.11
Carbon monoxide	percent	3.76	0.0	0.69	2.2	0.0	0.21
Cyanide	ppm	16.5	BDL	**	BDL	BDL	**
Hydrogen sulfide	ppm	42.5	BDL	**	BDL	BDL	**
Nitrous oxide	ppm	336	0.0	15.6	20.3	0.0	0.13
Other nitrogen oxides	ppm	484	0.0	38.9	70.2	0.0	9.6
Phenol	ppm	31.1	BDL	**	BDL	BDL	**
Pyridine	ppm	BDL	BDL	**	BDL	BDL	**
Sulfur dioxide	ppm	232.5	BDL	**	25.4	BDL	**
Total hydrocarbons	percent	13.98	0.0	1.6	11.4	0.0	0.59

* BDL - Below detectable limits.

** Average could not be computed.

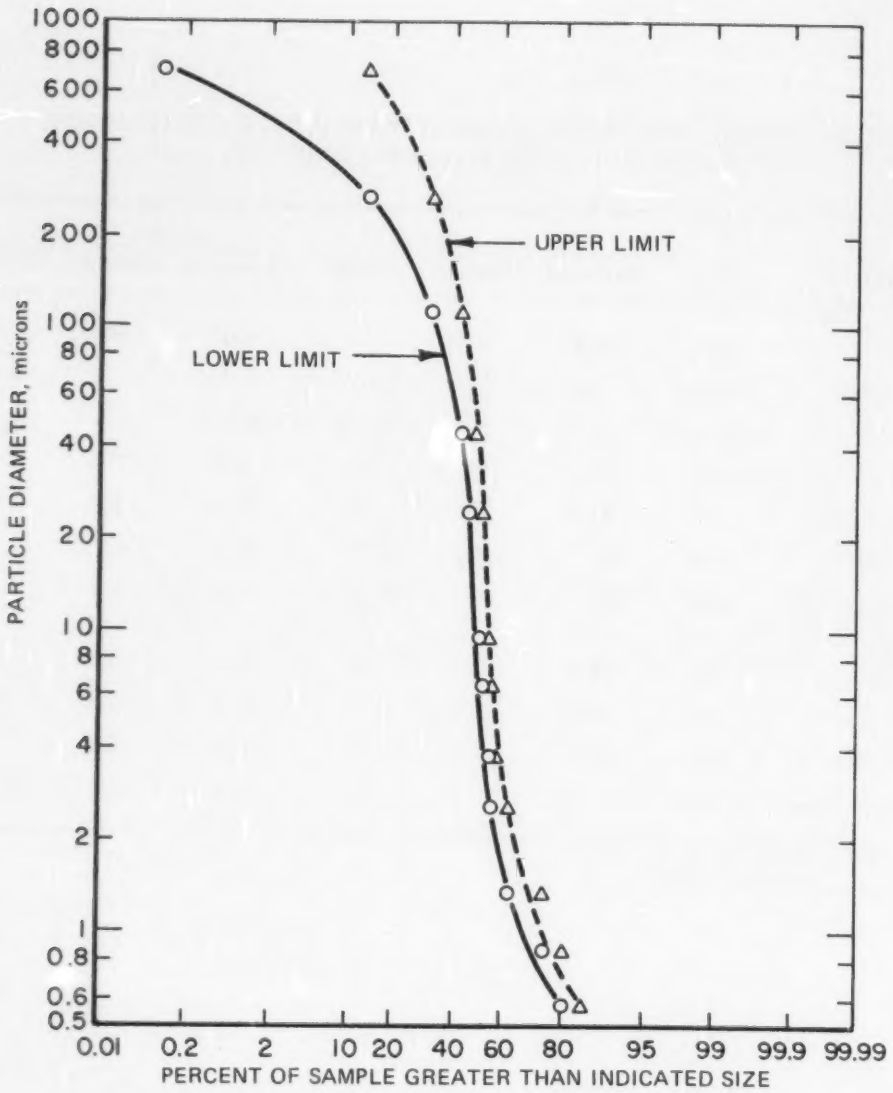

Figure 3. Size distribution of particulates collected during charging 15.0 tonnes (16.5 net tons) of coal with the AISI/EPA larry car

charging because of the intermittent time intervals used for collecting samples.

One investigator used microscopic techniques to identify and characterize emissions generated by a coke plant.[4] Identification of high-, medium-, and low-volatile coals which comprised the coals charged into the coke ovens was possible without difficulty. A particulate attributed specifically to the charging of coal into the ovens was designated as "coke balls". Coke balls were oval in shape and had an unusual network-like internal structure. The formation of coke balls was attributed to the thermal conditions encountered by coal particles as they are carried through the hot zone of an oven and out the adjacent open charging holes.

IV. PREHEATING OF COKING COAL

Larry-car-free charging of coke ovens did not originate as a method for controlling emissions during the charging operation. It was originated as a method for charging preheated coal into the ovens. The use of preheated coal in the production of coke has an important advantage to the coke-plant operator – an increase in production. The general amount of increase in productivity by preheating is illustrated in Figure 4.[10-29] The increase in coke-oven productivity is affected by the bulk density of the coal and the preheat temperature at the time the coal is charged to the oven. In addition to the increase in productivity, the use of preheated coal has other advantages: (1) lower quality metallurgical coals can be used in the coal blend, (2) the amount of energy required to make coke is lowered, and (3) preheated coal is so fluid that it does not require leveling of the coal charge in the oven.

Many coals and coal blends have been evaluated for their response to preheating.[31-36] In almost all cases the coke produced from preheated coals had properties equal to or better than the coke made from similar wet-coal blends. The use of lower quality metallurgical coals has been quite thoroughly evaluated.[31, 32, 34] The use of such a coal in a coking-coal blend was one of the factors in the decision of a midwest United States steel company (Inland Steel) to install a coke battery that would use a preheated coal charge.[29]

There has been much discussion pertaining to the total amount of energy needed to produce 1 ton of coke by the use of preheated coal, as compared with conventional coking using wet coal. No reports have been made of full-scale tests on commercial coke batteries to determine the total energy consumed in each method of making coke. However, estimates have been made comparing the energy requirements of the two methods. The preheating of coal charges was reported to provide a potential energy saving of 116 to 349 E+06 joules per tonne (27, 800 to 83, 300 kilogram-calories tonne, 100, 000 to 300, 000 Btu per net ton) of coke produced.[37]

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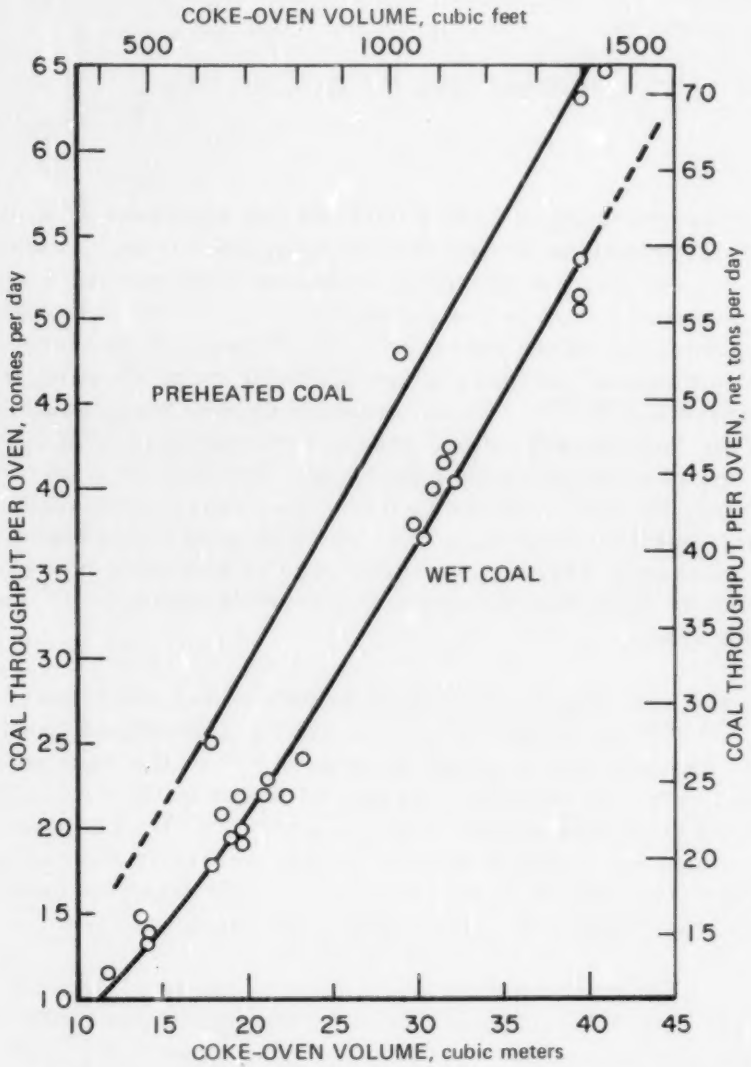

Figure 4. Possible increase in coke-oven productivity by preheating coal

The fluid characteristics of preheated coal permit it to achieve a uniform profile in the oven. Profiles for wet coal, dry coal, and preheated coal are illustrated in Figure 5.[38] The coal was charged to a 10-tonne (11-net ton) coke oven, using a larry car. The wet coal had moisture contents between 9.1 and 10.4 percent, the dried coal had moisture contents between 2.0 and 2.8 percent, and the preheated coals were charged to the oven at temperatures between 180 and 200 C (356 and 392 F).[38]

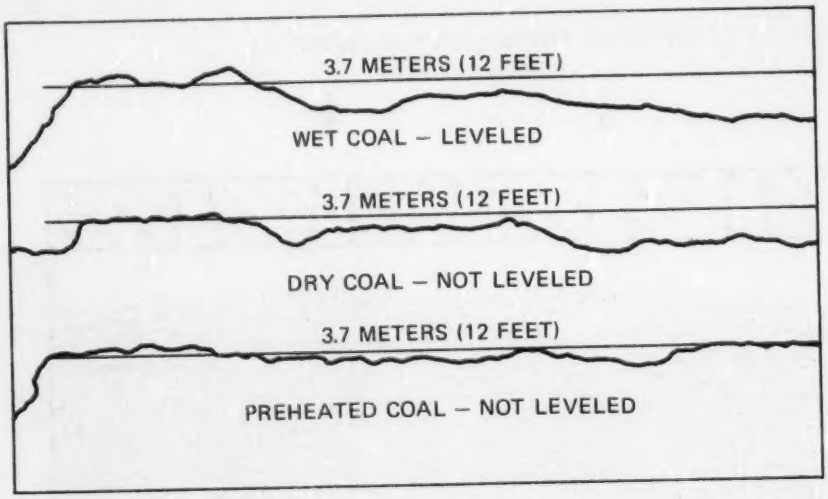

Figure 5. Profile of wet, dried, and preheated coal, top charged to a 10-tonne (11-net ton) coke oven with a conventional larry car

Another report concerning the self-leveling properties of preheated coal indicated a profile in a 4.2-meter (13.8-foot) coke oven, capable of coking 13.8 tonnes (15.2 net tons) of coal, as shown in Figure 6.[30] The preheated coal was charged with a conveyor system through the two charging ports indicated.

This self-leveling property of preheated coal eliminates the requirement for a leveling bar and thus the need for a leveling-bar door, which is a continued source of emissions during the leveling operation for conventional charging of wet coal.

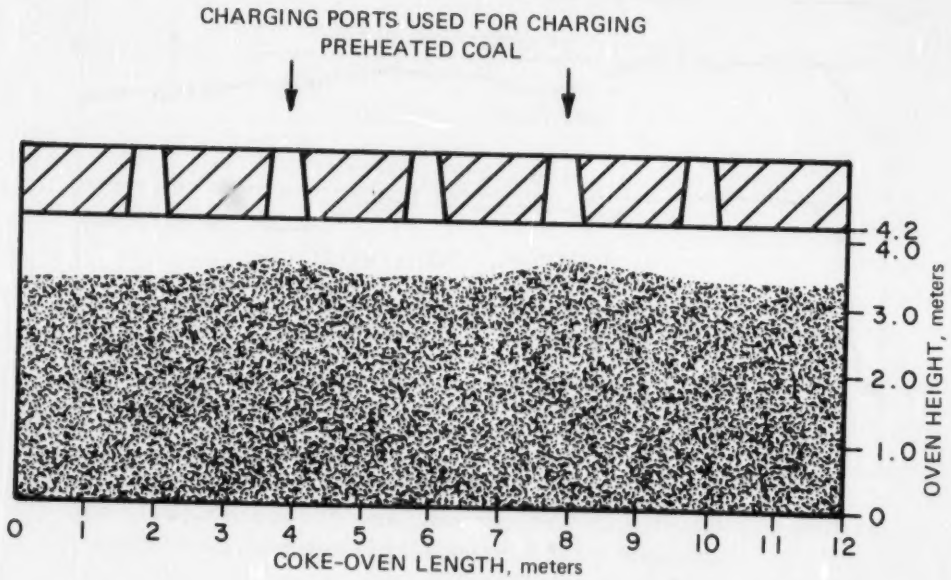

Figure 6. Profile of preheated coal charged to a 13.8-tonne (15.2-net ton) coke oven

V. LARRY-CAR-FREE CHARGING OF COKE OVENS

The high-fluidity characteristics of preheated coal and the necessity of minimizing the loss of heat during transport from the heating units to the ovens have resulted in the development of two systems that are used to charge coke ovens without the use of larry cars. One system was developed in the United States and the other in West Germany. The process developed in the United States is called the "Coaltek system"[39], and the process developed in West Germany is called the "Precarbon process"[40]. A third system which uses a covered larry car to charge preheated coal was developed by Simon-Carves, Ltd., England. A prototype is installed at the British Coke Research Association experimental coke plant.[26] This is known as the "Simcar system" and is included to provide a complete picture of the systems available for charging preheated coal.

THE COALTEK SYSTEM

The Coaltek system, which employs pipelines to convey the preheated coal from the preheaters to the coke ovens, was developed by the Semet-Solvay Division, Allied Chemical Company. The process is marketed today by Coaltek Associates.

Preheater

Research work started in the 1950's resulted in 10 patents for the Coaltek process.[42] The first, U. S. Patent No. 3,047,473 filed in September 1956, and granted in July 1962, was concerned with the preheating of coal and the basic concepts of pipeline charging.[43] The preheating system used in the Coaltek process was developed by the Research Center for the French coal industry and is known as the "Cerchar" preheater.[44, 45] A flow diagram of the Cerchar

preheating system used with the Coaltek process is shown in Figure 7.[46] This figure shows duplicate preheating systems feeding one distribution system (at the center of the figure).

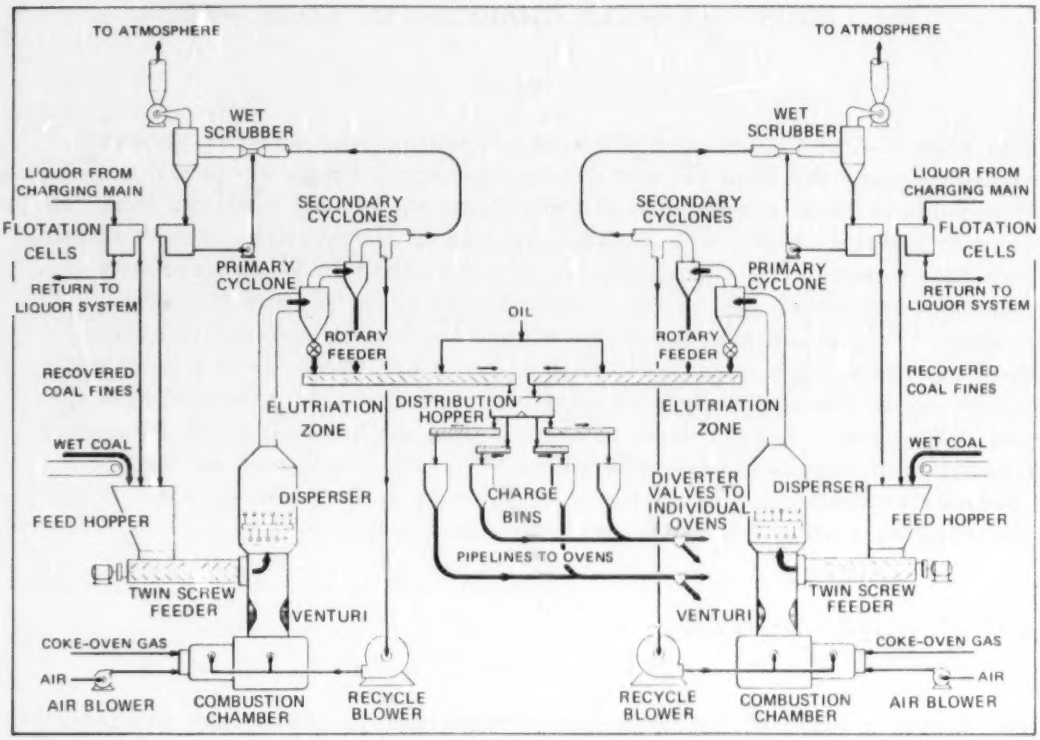

Figure 7. Preheating system for the Coaltek pipeline charging process for coke ovens

Ahead of the preheating system for the Ironton installation shown in Figure 7, wet coal is withdrawn from the coal bunkers by screw conveyors and is discharged onto a belt conveyor. A magnet located over the conveyor belt is used to remove any tramp iron. The coal is then screened to 2.5 cm (1 inch), and the oversize crushed to less than 2.5 cm (1 inch), which is then recombined with the undersize from the screen and discharged to the preheater feed hopper.

Coal from the feed hopper is fed into the preheaters by variable-speed screws. The wet coal, fed into the flash-drying entrainment section, comes into contact with a stream of hot low-oxygen gas, where it is partially dried and carried by the gas up to a dilute-phase fluidized bed. A rotating swinghammer crusher located in the lower part of the fluidized-bed chamber breaks the larger pieces of coal so that the largest size is about 6 mm (1/4 inch), with 90 percent passing 3 mm (1/8 inch). The rotating swinghammer also provides rapid dispersion and agitation of the coal particles in the gas stream. All preheated coal is transported upward by the gas stream and is recovered in conventional cyclone separators. About 90 percent of the coal is recovered in the primary cyclone and the remainder in four secondary cyclones arranged in parallel.[25] Figure 8 is an illustration of the external appearance of such a preheating system.[46]

Pipeline Charging System

Hot coal from the bottom of the cyclones is conveyed to a hot-coal receiving bin from where it is conveyed intermittently, as needed, to a higher measuring bin before being transported to the ovens. The coal is conveyed through a pipeline to the ovens whenever an oven is ready for charging. The pipeline manifold, illustrated in Figure 9[43], contains individual valves for each oven in a battery. Coal is transported through the pipeline by means of steam jets spaced along the pipeline. A steam jet is illustrated in Figure 10.[43] The oven operator activates the charging sequence from a control panel located at the end of the battery. When the predetermined amount of coal has been charged, the valve at the outlet of the measuring bin is automatically closed and the feeder is stopped. After a short time interval to provide for clearing of the pipelines and discharging the remaining coal into the oven, the flow of steam for conveying the coal through the pipeline is lowered to a standby rate.[25]

The gas from the outlet of the secondary cyclones is divided into two streams. The excess gas passes through a wet scrubber and is exhausted to the atmosphere. The recycle gas is increased in pressure by a recycle blower and returned to the combustion chamber where it is used to temper and add to the flow of combustion gases passing up through the preheater. Automatic controls are used to adjust the flow of recycle gas to that required to maintain the desired flow of gases through the preheating column.[25, 28]

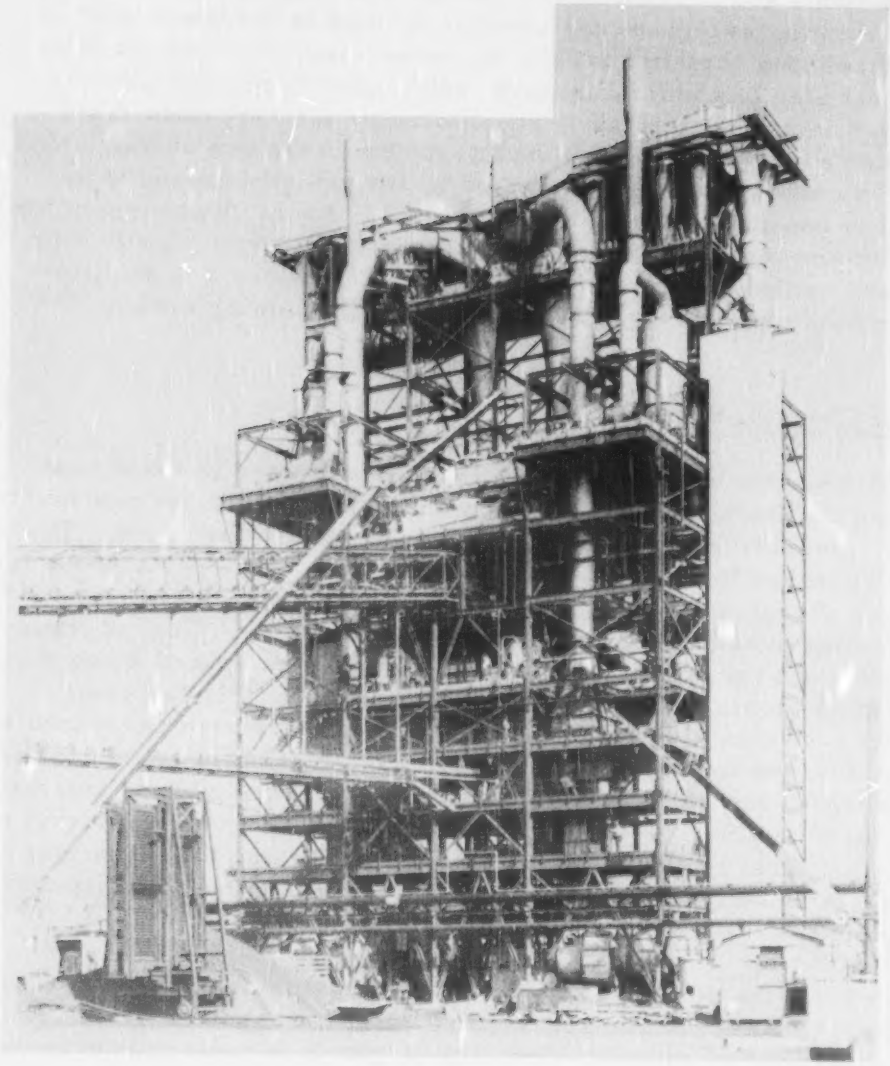

Figure 8. Coaltek pipeline-charging preheating system

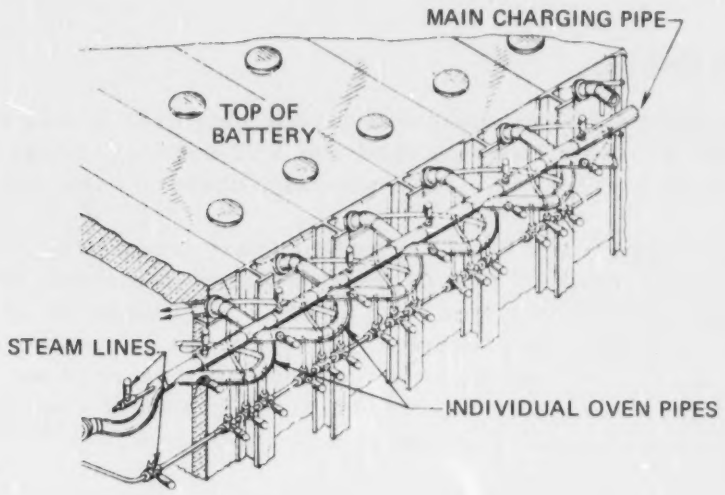

Figure 9. Coaltek system pipeline manifold for charging of coke ovens

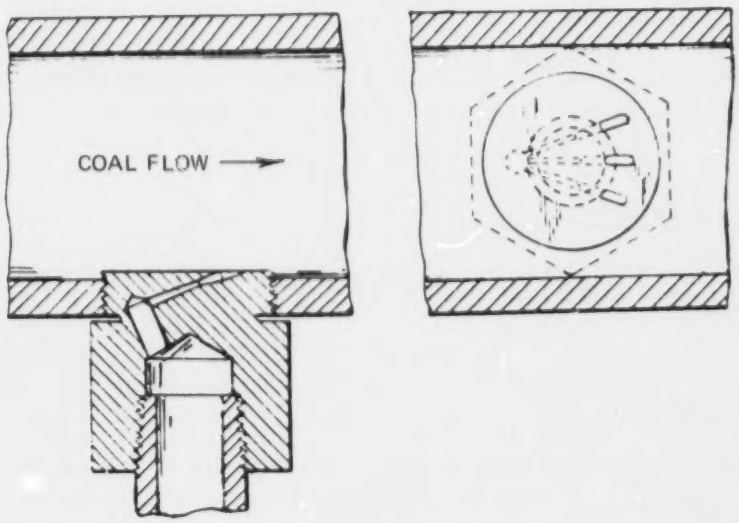

Figure 10. Section and top view of a steam jet in the Coaltek system pipeline

Utility Consumption

Gas consumption for preheating and carbonizing coal blends containing 8 percent moisture has averaged about 90 percent of that required for carbonizing wet coal in a conventionally charged coke oven.

Total steam requirements are reported to vary from 25 to 32 kilograms per tonne (50 to 65 pounds per net ton) of preheated coal. The steam is used primarily for heating pipes in various parts of the system, pressurizing the metering (charging) bin, conveying the coal through the pipelines, and purging the coke-oven entry pipes. Coal is pipelined to the ovens at a ratio of 100 kilograms of coal per kilogram of steam (100 pounds of coal per pound of steam).[25, 28]

Preheater electrical-energy consumption varies with the operating rate, which is controlled primarily by the requirements of the recycle blowers. At Ironton the electrical-energy requirements of the recycle blowers vary from 6.8 kilowatts per tonne at 18.1 tonnes per hour to 3.2 kilowatts per tonne at 36.3 tonnes per hour (6.2 kilowatts per net ton at 20 net tons per hour to 2.9 kilowatts per net ton at 40 net tons per hour). All other electric energy, including requirements for the pipeline system, amounts to 6.6 kilowatts per tonne (6.0 kilowatts per net ton).[25]

Clean-water consumption is about 9500 liters (2500 gallons) per day. The wet scrubbers use about 330 liters (87 gallons) per minute.

Coaltek Installations

Coaltek system installations throughout the world are listed in Table 4.[25, 28, 29]

Retrofit Capability

As with any new process or system, when there is a possibility for increasing production and/or providing improved control of emissions, the possibilities of retrofitting the process or system to existing facilities becomes an important factor to the steel-plant operator. Such is the case with pipeline charging of coke ovens.

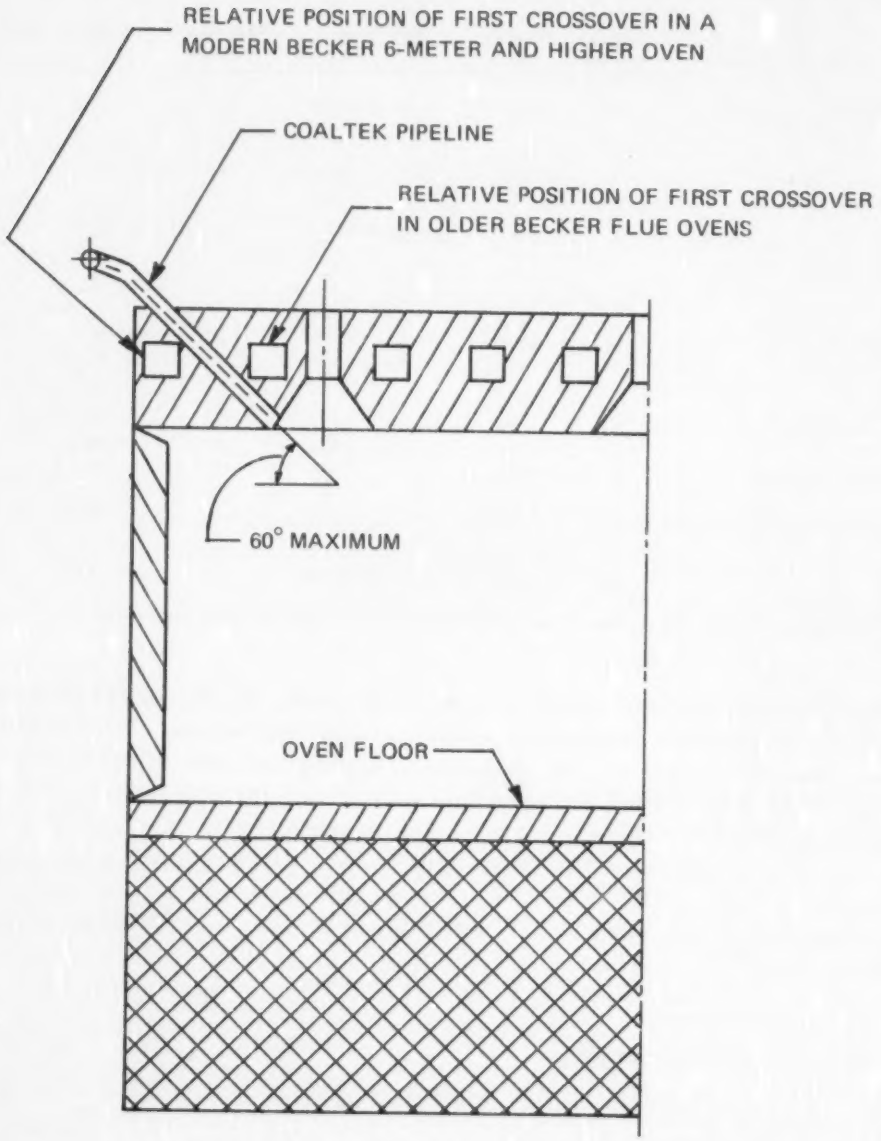
RELATIVE POSITION OF FIRST CROSSOVER IN A MODERN BECKER 6-METER AND HIGHER OVEN
COALTEK PIPELINE
RELATIVE POSITION OF FIRST CROSSOVER IN OLDER BECKER FLUE OVENS
60° MAXIMUM
OVEN FLOOR

Figure 11. Location of pipeline for existing coke ovens

TABLE 4. COALTEK SYSTEM INSTALLATIONS

Company and Location	Ovens, number	Startup Year	Coal Capacity per Oven, tonnes	Coal Capacity per Oven, net tons	Preheaters, number	Capacity per Preheater, tonnes/hr	Capacity per Preheater, net tons/hr
Alabama Byproducts Corp. Tarrant, Alabama	78	1974	24.9	27.5	2	72.5	80
Inland Steel Company East Chicago, Indiana	56	1974	29.7	32.7	2	90.7	100
	69	1977	33.4	36.8			
Jones & Laughlin Steel Corp. Aliquippa, Pennsylvania	56	1976	29.7	32.7	2	90.7	100
Semet Solvay Division, Allied Chemical Corp.							
Detroit, Michigan	70	1973	24.9	27.5	2	72.5	80
Ironton, Ohio	24	1970	12.7	14.0	1	36.3	40
British Steel Corp.							
Teeside, England	66	1976	24.9	27.4	3	79.8	88
	66	1977	24.9	27.4	2	79.8	88
Scunthorpe, England	75	1976	26.1	28.8	3	90.7	100
Norbottens Jarnverk Aktiebolag Lulea, Sweden	54	1976	35.7	39.4	3	72.5	80
SACILOR Carling, France	12	1974	11.7	13.9	1	13.0	14.

Exploratory engineering studies have been made on the possibilities of installing the Coaltek system on existing coke batteries. The major problem has been the angle of the pipeline entering the oven. On a new battery designed and constructed for pipeline charging, the angle of the downward-sloping pipe can be 10 to 60 degrees from horizontal. On existing coke batteries, the location of the first crossover flue presents a problem in the location of the entry pipeline. Research work has shown that the coal-entry pipeline can be positioned at 60 degrees from horizontal as shown in Figure 11.[46]

THE PRECARBON SYSTEM

The Precarbon system uses an enclosed Precarbon chain conveyor to charge preheated coal into conventional coke ovens. It was developed jointly by Didier Engineering GmbH and Bergbau-Forschung GmbH, both of Essen, West Germany.[47] The preheater is known as a "Precarbon Preheater".

Installation of the Precarbon plant began in 1970 and the preheating system was placed into operation in 1971.[40] A flow diagram for the Precarbon process is shown in Figure 12.[48]

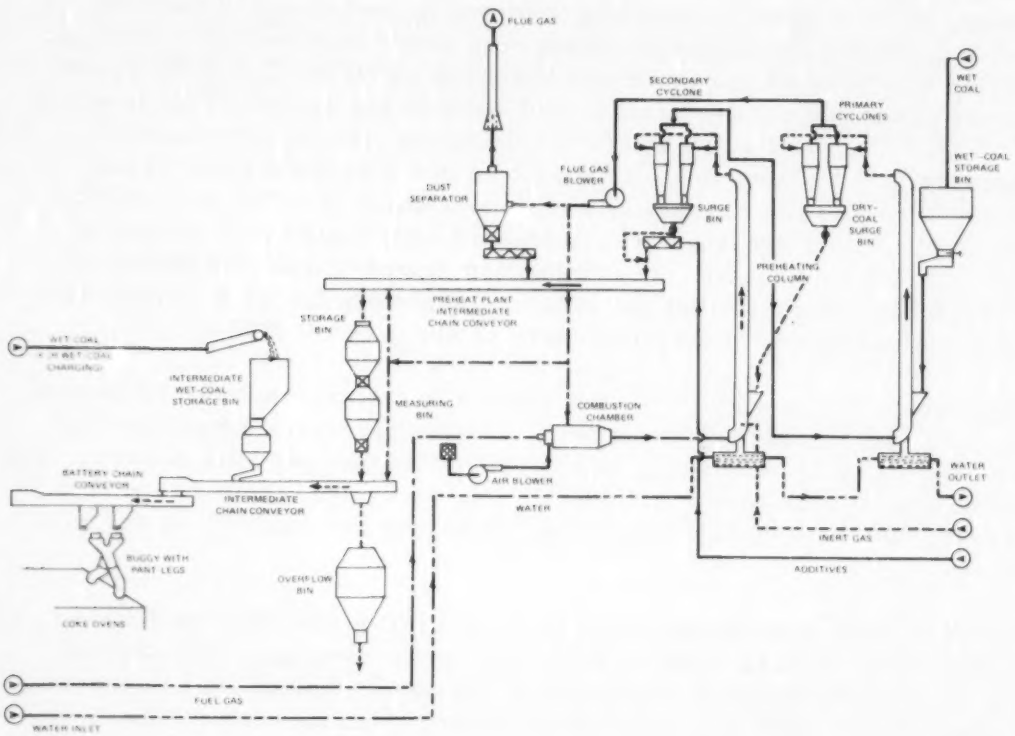

Figure 12. Flow diagram for the Precarbon process

Operation of the Precarbon System[48]

The Precarbon system is characterized by the combination of a vertically arranged 2-stage flash-drying system for the thermal pretreatment of coking coal with a special chain conveyor arranged above the batteries for charging the ovens.

The basic arrangement of the system is shown in the process diagram. The data used for illustration in the following discussion are based on

a coal with 10 percent moisture content which has been preheated to 200 C (392 F). These figures will vary in relation to the moisture content and the desired preheating temperature.

The wet coal is conveyed to the feed bunker by means of a conveying system, is measured by metering equipment, and is fed to the first flash leg (the drying stage) by means of a centrifugal feeder. The coal is dried to 2 percent moisture and heated to about 80 C (176 F) by hot carrier gases which have been cooled down in the second stage to about 280 C (536 F). At the top end of the drier leg, the predried coal is separated in a cyclone and delivered by gravity to the bottom of the second flash leg (the preheating stage) into which it is fed by a centrifugal feeder. The predried coal is treated with heated carrier gas at 550 C (1022 F) generated in a combustion chamber and an addition of recycled hot gases, so that the coal is completely dry at the upper end of the preheating leg at a temperature of about 200 C (392 F).

After separation in a cyclone, the thermally treated coal can be treated with a Precarbon additive in order to reduce carryover when "on-the-main" charging is used and also to achieve the desired bulk density. The coal is then stored in an intermediate bunker system from where it is conveyed to a subsequent measuring bin having the capacity of one oven charge.

The hot carrier gas is generated in a combustion chamber by burning gaseous fuels such as blast-furnace gas, coke-oven gas, and natural gas. Recycled off-gases are added to the gas to reduce its temperature to about 550 C (1022 F). In order to benefit from the counterflow principle (i.e., to utilize relatively low temperatures in the second stage), the hot flue gas is first introduced to the second stage (preheating stage) to thermally treat the predried coal. Since the hot carrier gas contains fine dust after passing through the first-stage cyclone, it is cleaned in a double cyclone. The coal-carrier gas mixture is then fed to the second stage. After passing the main blower, which circulates the carrier gas, a part of the gas is recycled to the combustion chamber and the remaining part is thoroughly cleaned in a heavy-duty dust collector and released to the atmosphere.

The blower arrangement automatically creates the following pressure distribution in the plant. Minimum pressure is maintained at the cyclone of the drying stage. The drying stage itself creates a pressure loss of about 300 mm (11.8 in.) w.g. as does the preheating stage, so that a

pressure of approximately ±0 mm w.g. exists in the combustion chamber.

The process of thermal pretreatment is governed by three control systems and is fully automatic. In order to prevent overheating of the system and of the coal, the flue-gas temperature at the end of the second stage is used as a control point. For safety reasons, the addition of combustion air is controlled by this control point. In a separate control circuit, the gas addition with the specified excess air rate is controlled. A third control circuit regulates the amount of recycled off-gas to the combustion chamber so that at the entrance to the second stage, the pressure is neither below or above the set value. Variations in the moisture content of the coal charge and variations in the throughput thus are automatically controlled so that at any time a satisfactory operation at optimum conditions is maintained.

In case of emergency shutdown, the coal in the flash legs drops into water seals at the bottom of the individual stages from where it can be easily removed.

The thermally pretreated coal from the preheating plant is conveyed by parallel operating chain conveyors to an oven for charging and is charged "on-the-main" through a chute buggy, without atmospheric pollution. Each chain conveyor charges coal to two charging holes through individual pant legs. The Precarbon process requires only two charging holes. In case wet coal is to be charged with a chain conveyor, four charging holes are used.

The operational sequence of the Precarbon charging process is as follows:

(1) Charging is first made through the two inside charging holes by setting a flap in the pant leg. The charge level in the oven is measured by Precarbon level probes.

(2) When the desired charge level is reached below the charging holes, which is measured by level probes, the flap is automatically switched.

(3) Charging is continuing through the two outer charging holes.

(4) The chain conveyors are switched off on response from the level probes and the probes are automatically retracted from the oven. Levelling of the oven charge is eliminated with the Precarbon process.

The coal remaining in the chain conveyor between two oven charges is transported back to the battery charging station, by reversing mechanizms on the chain conveyor, and is again charged in the following cycle. (The chain conveyor has a continuous intermediate bottom.) Since levelling is not required by the Precarbon process, the chute buggy and coke-pushing machine are independent of each other. For this reason, any desired carbonization cycle may be used.

A measuring bin is available which permits batch charging of ovens, instead of measuring the coal volume by the level probes. In the case of batch charging, the coal quantity is weighed in the measuring bin and discharged to the empty chain conveyors, transported to the oven, and the entire quantity of weighed coal charged to the oven. However, such practice requires more time.

In case of failure of the preheating plant or in reducing the coke throughput from the ovens, the Precarbon process permits the charging of wet coal by means of the chain conveyor and the chute buggy. It is then necessary to install a bunker system (storage and measuring bunker) for the wet coal above the chain conveyor. While thermally pretreated coal may, in emergency cases, be charged through one chain conveyor, both chain conveyor systems must be used when charging wet coal.

When charging wet coal, the two exterior charging holes are charged first. When the desired level of coal is reached, the changeover flap is automatically switched and the two inside charging holes are filled, until the level probes respond and are retracted. During the subsequent levelling, coal is charged through one inside charging hole only and the period is limited by a time relay (i.e., during levelling, the chain conveyor operates for a short preset period).

On existing plants it is often necessary to modify the Precarbon process so that only one chain conveyor in connection with a pant leg is used. Ovens up to 12 meters long can be operated without difficulty in this way.

Precarbon System Installations

In addition to the prototype installation at Ruhrkohle AG, Essen, West Germany, Precarbon systems have been installed on new coke batteries listed in Table 5.[48]

TABLE 5. PRECARBON SYSTEM INSTALLATIONS

Company and Location	Ovens, number	Startup Year	Coal Capacity per Oven		Systems, number
			tonnes	net tons	
U. S. Steel Corporation, Gary, Indiana	57	1975			3
	57	1976			3
Nippon Steel Corporation, Oita, Japan		1977			3
		1977			3

Retrofit Capability

There have been no specific reports in regard to the retrofit capability of the Precarbon system. However, because the prototype Precarbon system was placed into operation in 1971 on five experimental coke ovens constructed in 1968, capability for retrofit is obvious.

THE SIMCAR SYSTEM

Although the Simcar system does employ larry cars for charging of preheated coal in coke ovens, it is included in this report to provide full coverage on methods that can be used for charging preheated coal. The Simcar system, developed by Simon-Carves Ltd., England, was first installed at the British Coke Research Association Center at Chesterfield, England.[49]

Preheater

The coal preheater used with the Simcar system is the Rosin preheater. The preheater at the British Coke Research Association Center experimental ovens was placed into operation in 1967.[36]

Simcar Charging

The Simcar system employs a special larry car to transport the preheated coal from the hot-coal bunkers to the coke ovens. The larry car includes a scrubber to control emissions during charging, with the addition of rotating seals on the tops of the coal hoppers to prevent the emission of particles of heated coal from the hoppers and to minimize heat losses.

Simcar System Installations

Coke-oven batteries using the Simcar system for the charging of preheated coal are given in Table 6.[26, 37, 50]

TABLE 6. SIMCAR SYSTEM INSTALLATIONS

Company and Location	Ovens, number	Startup Year	Coal Capacity		Pre-heaters, number	Capacity per Preheater	
			tonnes	net tons		tonnes/ hr	net tons/ hr
British Coke Research Assoc. Chesterfield, England	NA	1967	10.0	11.0	1	5	5.5
British Steel Corp. Brookhouse, England	NA	NA	13.6	15.0	1	55	60.6
Anglo American Corp. Africa	NA	NA			1	55	60.6
ISCOR Pretoria, South Africa	NA	NA			3	88	97.0

NA = Not available.

Retrofit Capability

The retrofit capability of the Simcar system is illustrated by the fact that it was installed on an existing coke battery, the Brookhouse battery in England.[50]

LARRY-CAR-FREE CHARGING AIR-POLLUTION CONTROL POTENTIAL

The true larry-car-free systems for charging coal to coke ovens have the potential for eliminating emissions to the atmosphere. Since the systems are enclosed, there should be no possibility for emissions unless there is some type of major breakdown in the systems that could not be corrected in a minimum amount of time. Under routine operating conditions, emissions should be completely absent. Direct measurements of emissions from charging operations have not been made successfully so it is impossible to state what the specific reduction of overall coke-oven emissions would be in milligrams per tonne of coal charged or tonne of coke pushed (grains per net ton of coal charged or grains per net ton of coke pushed).

The larry-car-free charging systems discussed in this report all are used to charge preheated coal to the coke ovens. Some emissions to the atmosphere may occur because of the overloading of the scrubbers that are used to clean off-gases from the drying units. In such cases, there may be an intermittent emission of pollutants to the atmosphere, which can be corrected by adjustments to the coal-drying system.

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